TACEC

Terminal Area Capacity Enhancement Concept

Advanced ATM Concept for 2020

prepared for
VAMS Technical Interchange Meeting #3
NASA Ames Research Center
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Agenda

- TACEC Overview
- Results of investigations
- Revised Concept focus
- Impact of revision on TACEC Core Ideas
- Objective Statement
- Summary

Terminal Area
Operating Domain

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- **The Terminal Area is defined as airspace surrounding an airport or airport group (similar to today's TRACON) as well as the airport surface (runway, taxiway and ramp). In addition the Terminal Area includes gate and street side operations.**

- **For comparison purposes the Terminal Area is similar to the operations environment addressed in the FAA's Operational Evolution Plan for Arrival and Departure Rate**

Capacity can only be claimed if you can put the wheels on the ground and the passengers in the terminal……....

TACEC Overview

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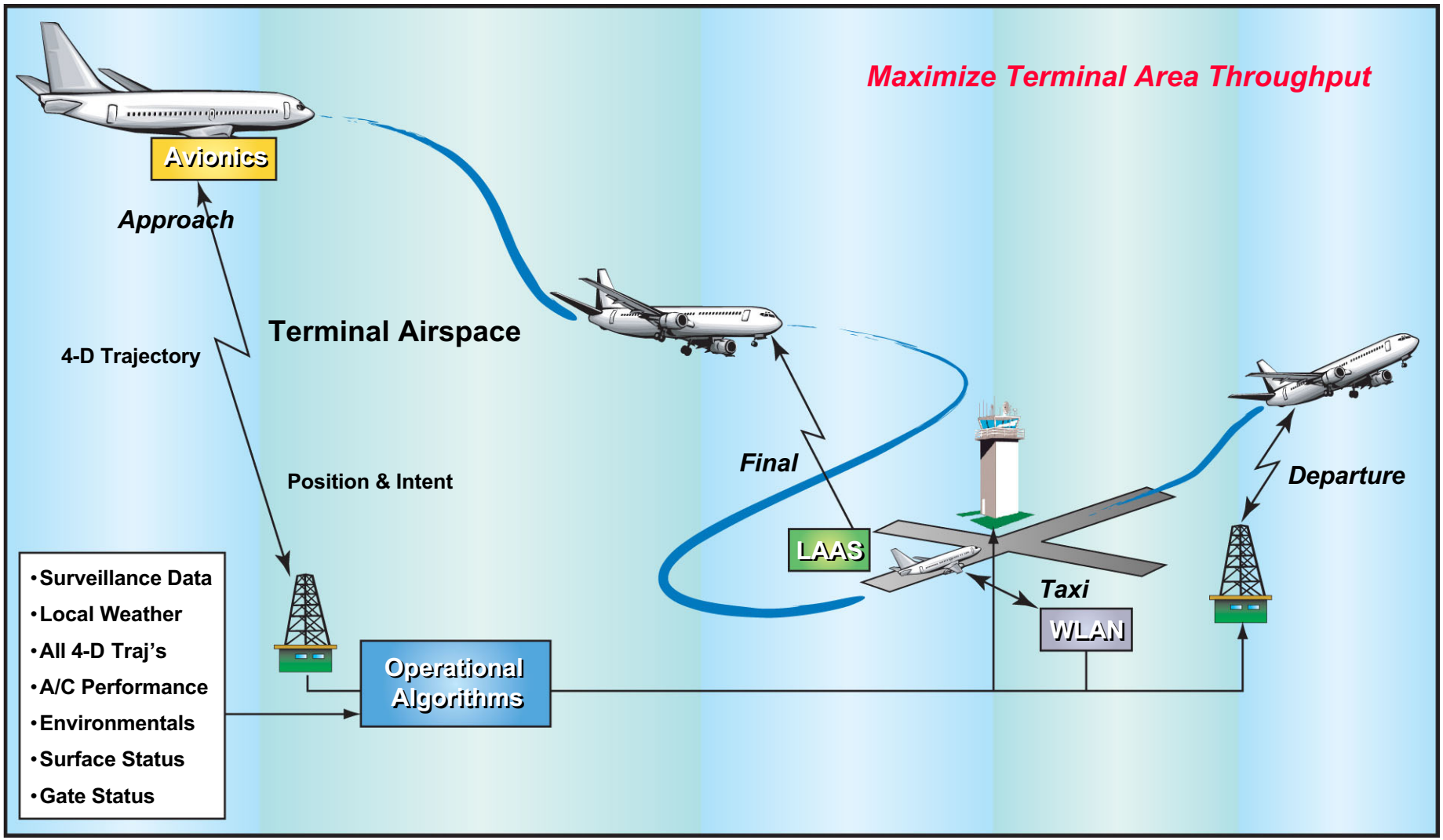

Terminal Area Capacity Enhancement Concept

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Increasing capacity in the Terminal Area relies on following Core Ideas:

- **Accurate 4D Trajectory Calculation and aircraft execution of required trajectories**
- **Highly reliable and secure data link**
- **Reduced separation standards**
- **Improved surveillance**
  - **WAAS enhanced GPS**
  - **Multi-sensor surveillance fusion**
  - **Mode S MSSR**
- **Airborne self separation**
- **Complex finals - curvilinear, multi-aircraft formations landings using LAAS**
- **Optimized surface movement**
- **Integrated Terminal Area information network (all stakeholders)**
- **Human Centered System**

Concept Review Results

Element	Projected Capacity Benefit	Comments
4D Trajectories/Aircraft execution of required trajectories	10%	Optimized for current arrival/departure operations (Similar to FAST)
Reduced separation standards	No direct benefit	Necessary to support optimized 4D trajectories
Airborne self separation	No direct benefit	Element of redundancy in fully automated 4D trajectories
Complex finals - curvilinear	Minimal benefit	Primary benefit is noise reduction
Multi-aircraft formation landing	Linear increase	Fundamental change in terminal operations
Optimized surface movement	Linear increase	Must accommodate multi-aircraft landings

Interim Conclusion

- **Terminal area does not provide sufficient airspace to significantly increase the NAS capacity.**
  - **Capacity gains for optimizing sequencing, approach/departure maneuvers, and airspace usage cannot provide the needed growth.**
  - **In a gate to gate evaluation, the gains achieved in the enroute domain can not be translated into increased passenger movements.**

- **Building more runways can provide the needed capacity, but not all airports can accommodate the requirements.**
  - **New airport facilities require 20+ years to construct**
  - **Current parallel runway spacing needs significant real estate**
  - **Political/Social issues remain**

- **Closely spaced parallel landings can provide needed capacity for all airports**
  - **revolutionary approach in wake vortex avoidance using "flight corridors" drastically reduces needed real estate.**

Wake Vortex Avoidance using Flight Corridors[1]

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- Revolutionary NASA concept based on minimizing aircraft separation to avoid wake vortex avoidance.
- Instead of waiting (time=distance) until the vortices disperse, the flight corridor concept establishes "tunnels" in space which represent each aircraft's wake vortex generation over time.
- These tunnels become the "non-transgression" zones similar to today's parallel runway operational concept.
- Multi-aircraft landings and departures can be configured by dynamically establishing the tunnels as flight corridors, monitoring weather and actual aircraft position.

1. Rossow, Vernon R. "Use of Individual Flight Corridors to Avoid Vortex Wakes", AIAA Atmospheric Flight Mechanics Conference, 5-8 August 2002, Monterey, CA

Re-Stated Core Ideas

- **Accurate 4D Trajectory Calculation and aircraft execution of required trajectories**
  - **Focus on the "entry/exit" of dynamic flight corridors. Accurate sequencing, position and timing of all aircraft entering or leaving the terminal area to match corridor needs.**
- **Improved surveillance**
  - **Accuracy, reliability, and availability to support 4D trajectory requirements.**
- **Airborne self separation**
  - **What role in flight corridor operation?**
- **Complex finals - curvilinear, multi-aircraft formations landings using LAAS**
  - **Focus on LAAS capability to achieve needed accuracy to control flight paths.**
- **Optimized surface movement**
  - **Accommodate multi-aircraft landings/departures**
- **Integrated Terminal Area information network (all stakeholders)**
  - **Fully integrated weather monitoring (both ground and airborne sources) to predict impacts on wake vortex movement.**

Human Centered Systems and Flight Corridors

- **Multiple Flight Corridors are a paradigm shift from today's parallel runway standards.**
  - **Entirely new concept in final approach monitoring is required**
  - **Roles of human and automation must be re-evaluated**
- **Key goal of automation/display solution is the maintenance of appropriate situational awareness for human (ground and flight crew) operators.**
  - **Need to deal with exception cases**
  - **Dynamic recovery performance**
- **New visualization approaches will be developed and evaluated.**

Key Issues Beyond Technology

- **Environmental**
  - **Significantly increasing the number of operations at today's airports will generate pollution/noise output beyond allowable levels.**
  - **Vehicle technology development over the next 20 years is not adequate to offset 100% increase in airport operations.**
  - **Flight paths can be used to minimize noise, but constraints remain on approach/departure routing.**

- **"Enterprise" solution which trades benefits gained by capacity increases with standards of living by those affected is needed.**

Revised Objective Statement

TACEC will provide significant capacity increase in the Terminal Area domain by utilizing the following operational approaches;

1. **Multiple aircraft landing and departures using dynamic flight corridors to insure wake vortex free operations.**
2. **Up-linked 4D trajectory flight paths optimized for staging the aircraft's entry/exit into/from the flight corridors.**
3. **Optimized surface movements (taxi routing, gate assignment, etc) to allow multi-aircraft operations.**
4. **Human centered automation approach which maintains required situational awareness in flight corridor operations.**

Summary

- Terminal Area Capacity Enhancement is primarily dependent on efficient wake vortex avoidance.
- A novel approach to avoiding wake vortices has been proposed by NASA using the idea of a “flight corridor” as a non transgression zone.
- Implementation requires both accurate, reliable, and available wake vortex location and aircraft position knowledge.
- Raytheon in partnership with NASA will investigate the feasibility of such a solution based on;
  - LAAS, WAAS performance and interaction with aircraft (both current and future)
  - Integrated weather solutions (ground and aircraft based sensors)
  - Human Centered automation solution
  - Surface movement operations for multi-aircraft arrival/departures